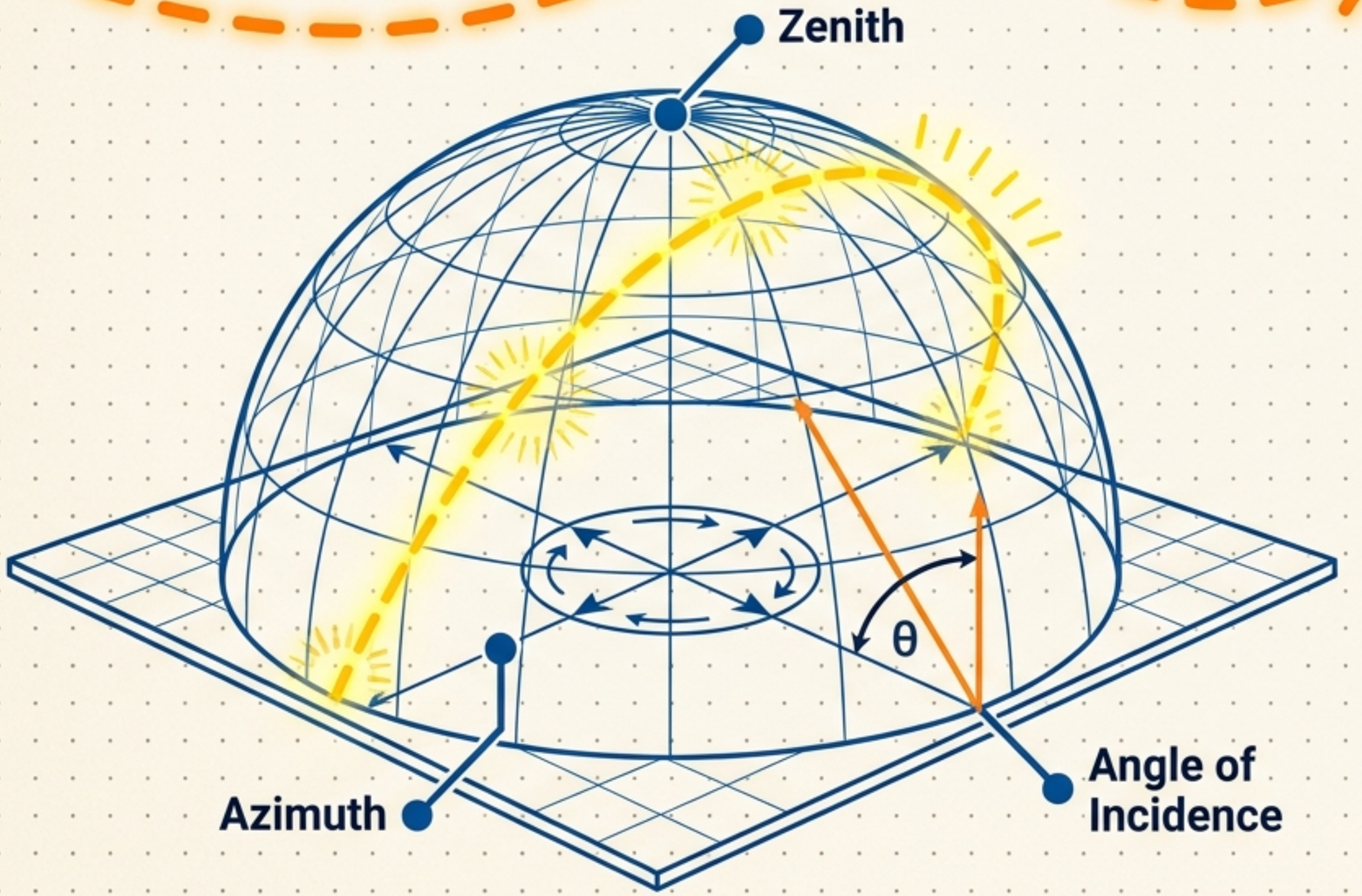
Connecting the Solar Dots: A Builder's Guide to PV Installation

1

Mastering the elements of solar design, from theoretical physics to physical hardware.

NotebookLM

Q1: Where does our power begin? (The Sun's Path)



The Answer

It begins with the angle of the sun. The installation angle varies from season to season depending on the geographical location.

The Ingredients of Light

GHI (Global Horizontal Irradiance): Total solar radiation on a horizontal surface.

DNI (Direct Normal Irradiance): Radiation received in a straight line from the sun.

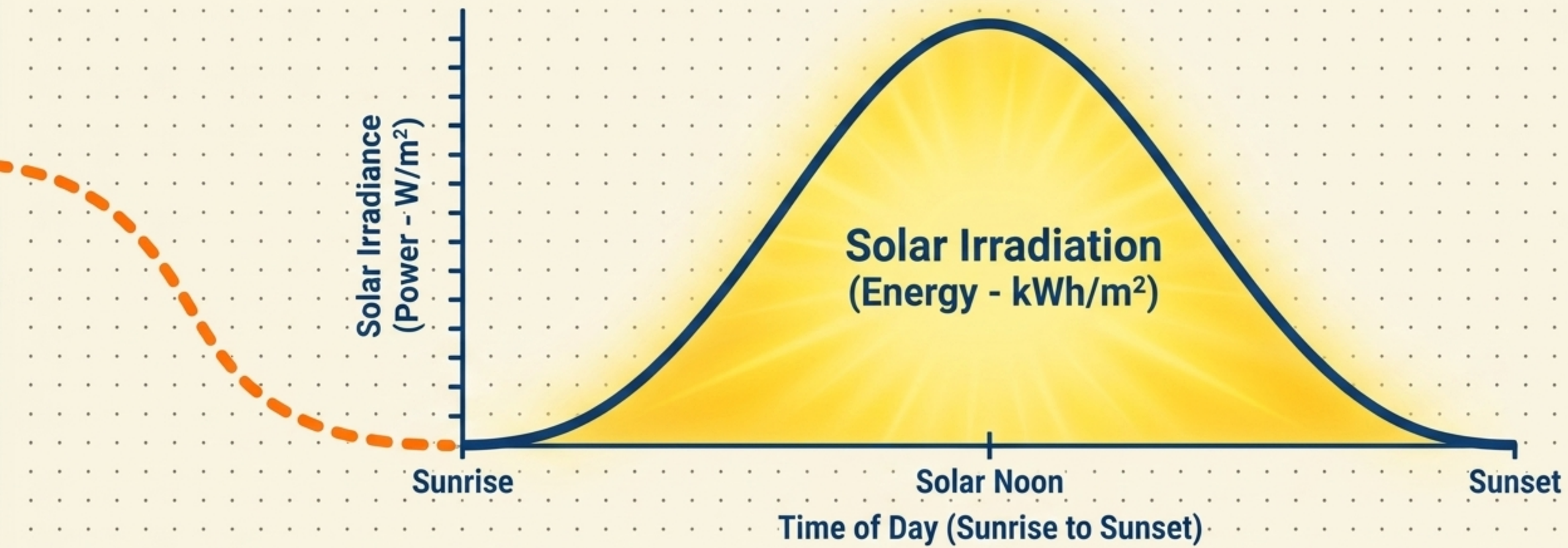
DHI (Diffuse Horizontal Irradiance): Scattered light.

The Formula

$$GHI = DNI \times \cos(\theta) + DHI$$

NotebookLM

Q2: How do we measure the light? (Irradiance vs. Energy)



Power is the Peak

Solar Irradiance is the immediate power hitting the surface.

Energy is the Area

Solar Irradiation (or Insolation) is the total volume of energy captured over time.

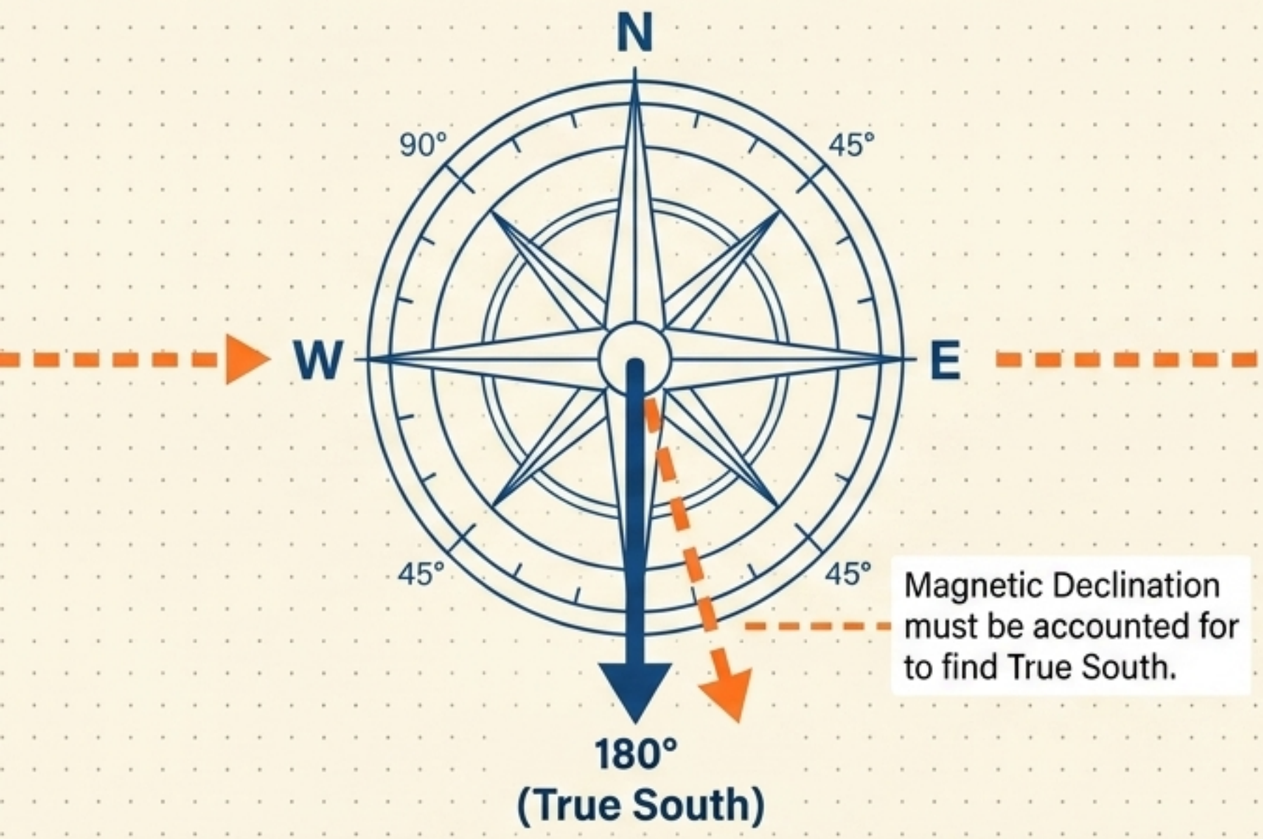
The Rule

Power × Time = Energy

NotebookLM

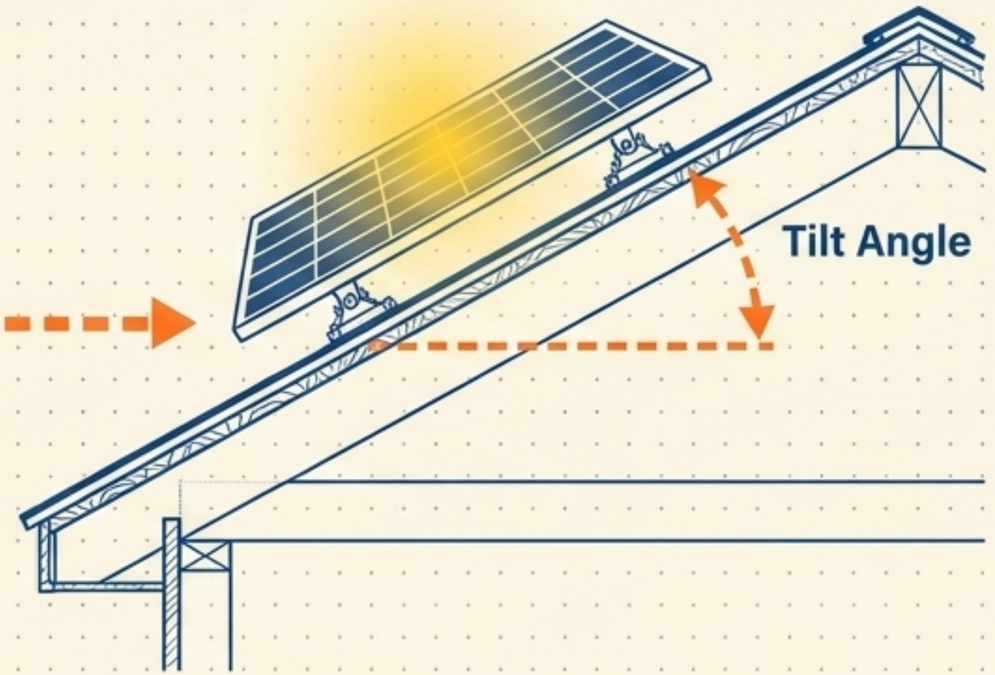
Q3: What is the perfect angle? (Orientation & Tilt)

Azimuth (Direction)



Fixed arrays should face True South in the Northern Hemisphere (and True North in the Southern Hemisphere).

Tilt (Angle)



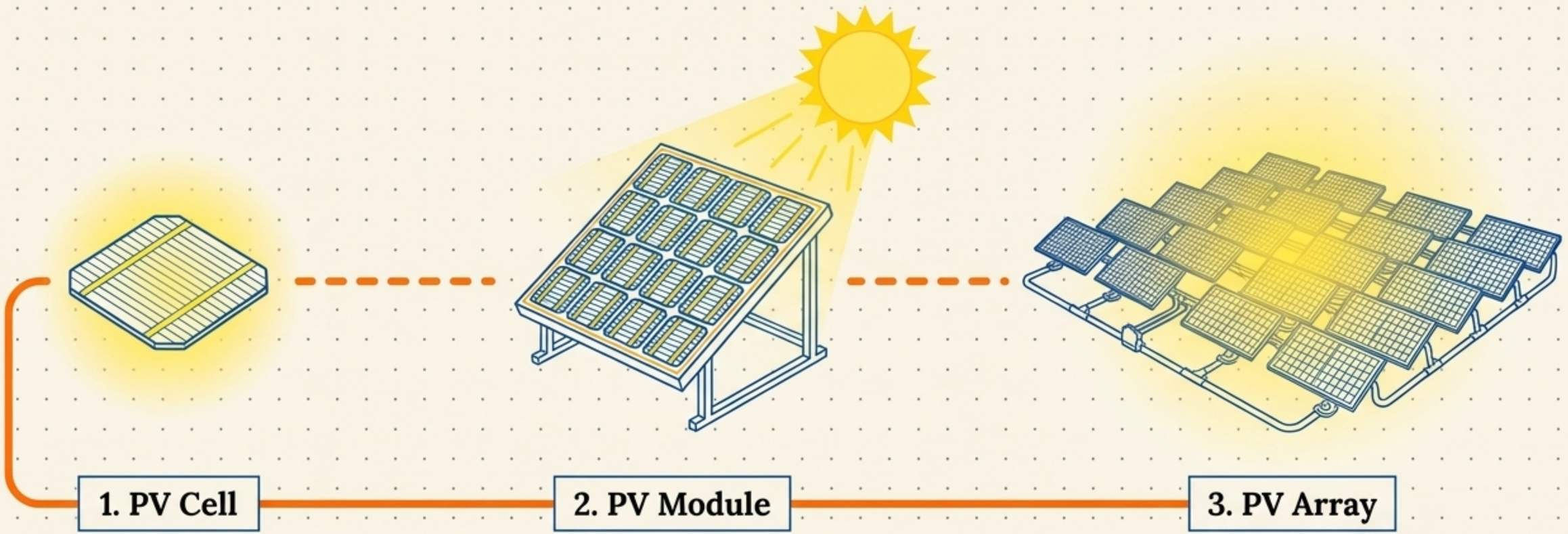
The optimal tilt generally matches the site's latitude.

Seasonal Adjustments:

- Winter-dominant loads: Tilt at Latitude + 15°
- Summer-dominant loads: Tilt at Latitude - 15°

NotebookLM

Q4: How do we catch the light? (PV Modules & Arrays)

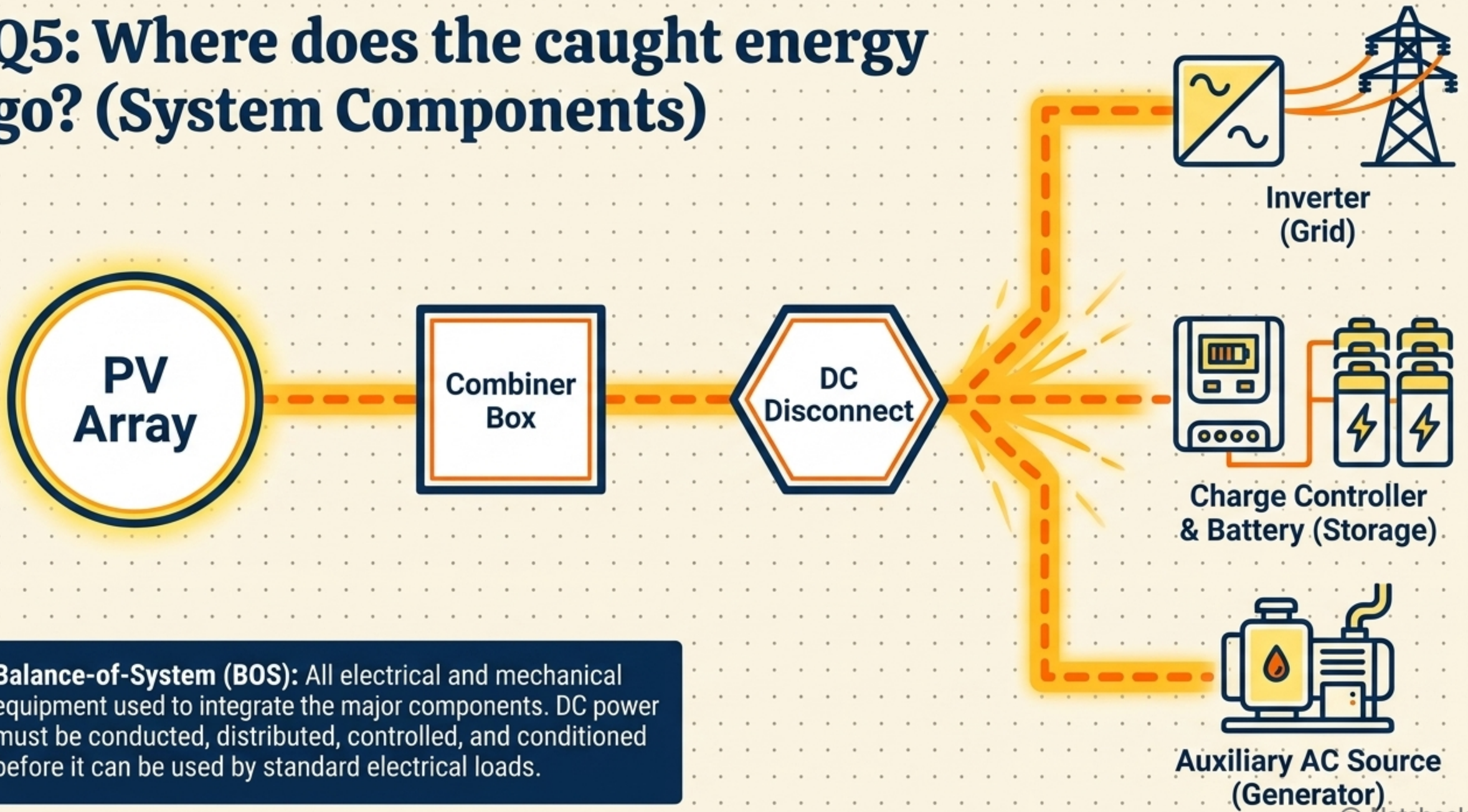


The **PV array** is the heart of the system. It is a power generation unit that translates solar irradiance directly into DC electricity when exposed to sunlight.

CAUTION: Once solar panels are exposed to sunlight, they immediately start generating DC voltage.

NotebookLM

Q5: Where does the caught energy go? (System Components)



Balance-of-System (BOS): All electrical and mechanical equipment used to integrate the major components. DC power must be conducted, distributed, controlled, and conditioned before it can be used by standard electrical loads.

NotebookLM

Q6: Big or small? Grid or island? (System Types)

Systems are classified based on the loads they operate and their connection to other power sources.

1. Grid-Tied (Utility connected, no storage)	2. Stand-Alone (Islanded)	3. Multi-Mode (Grid + Battery backup)
✓ Inverter ✗ Battery	✓ Battery ✓ Charge Controller ✓ Inverter Battery provides DC power to inverter.	✓ Battery ✓ Multi-mode Inverter Provides grid backup to critical loads.

NotebookLM

Q7: How do we stay safe up high? (OSHA & Planning)

The Reality

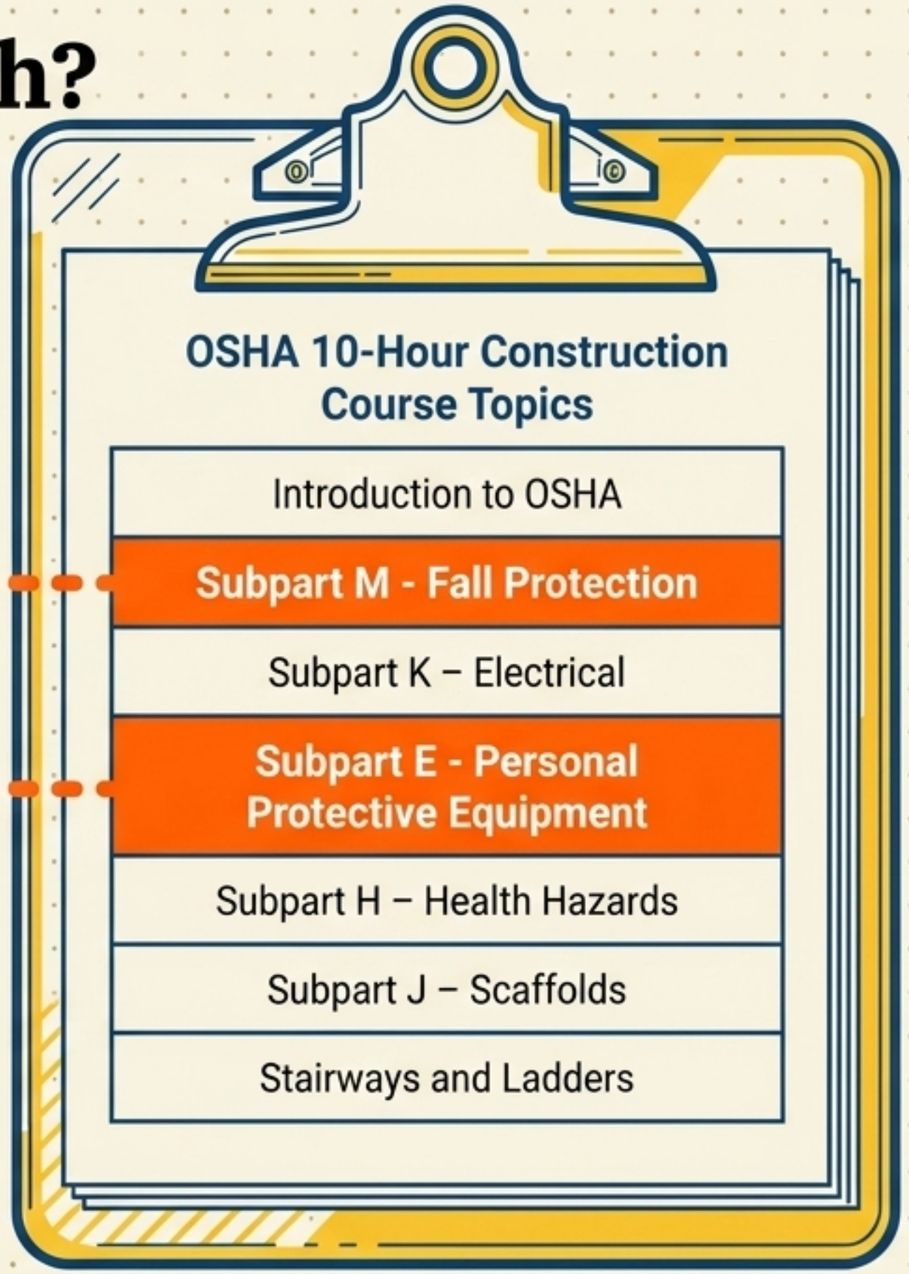
Falls are the leading cause of death in the construction industry.

The Rule

OSHA requires fall protection for roofs, walkways, holes, or skylights where a worker can fall **6 feet or more**.

The Prerequisite

A site-specific safety plan must be in place before work commences. (Pre-assemble panels on the ground when possible).


OSHA 10-Hour Construction Course Topics
Introduction to OSHA
Subpart M - Fall Protection
Subpart K – Electrical
Subpart E - Personal Protective Equipment
Subpart H – Health Hazards
Subpart J – Scaffolds
Stairways and Ladders

NotebookLM

Q8: What holds us back from falling? (PPE & Fall Protection)

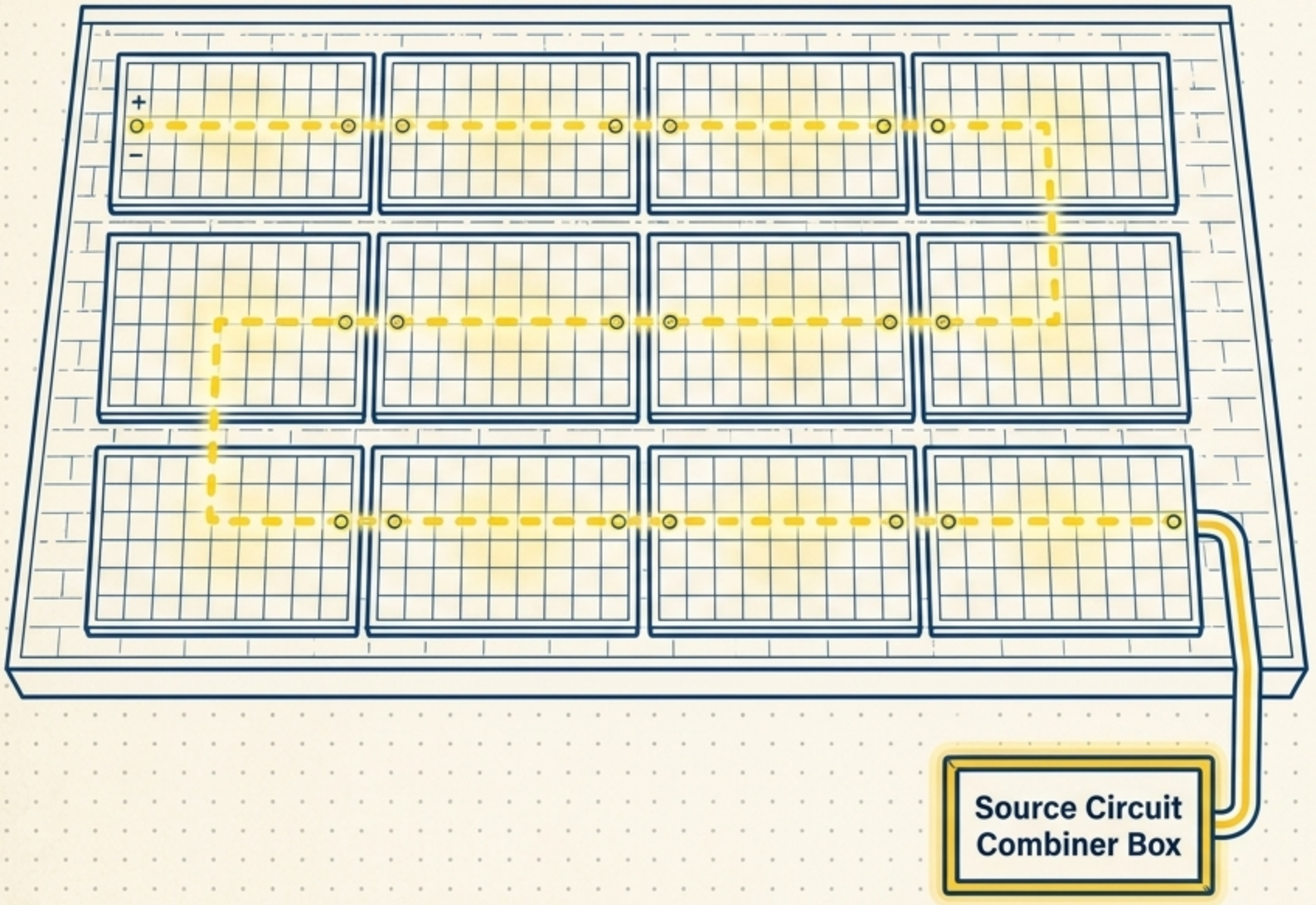
1. **Roof Anchor**: Securely fastened to the structure.
2. **Lanyard/Lifeline**: The deceleration device connecting the anchor to the worker.
3. **Body Harness**: The wearable safety gear.

Passive Protection: Guardrails (top rails must be between 39 and 45 inches tall with a 3-1/2 inch toe board) or Safety Nets (deployed no further than 30 feet below work).

Active Protection: The PFAS system requires specialized training to properly use and maintain.

NotebookLM

Q9: How do we link the panels together? (Stringing)



Wiring the Array

Modules are connected in series strings to build voltage.

The Journey

Strings are brought together at the Combiner Box, passed through a DC Disconnect, and routed toward the power conditioning equipment.

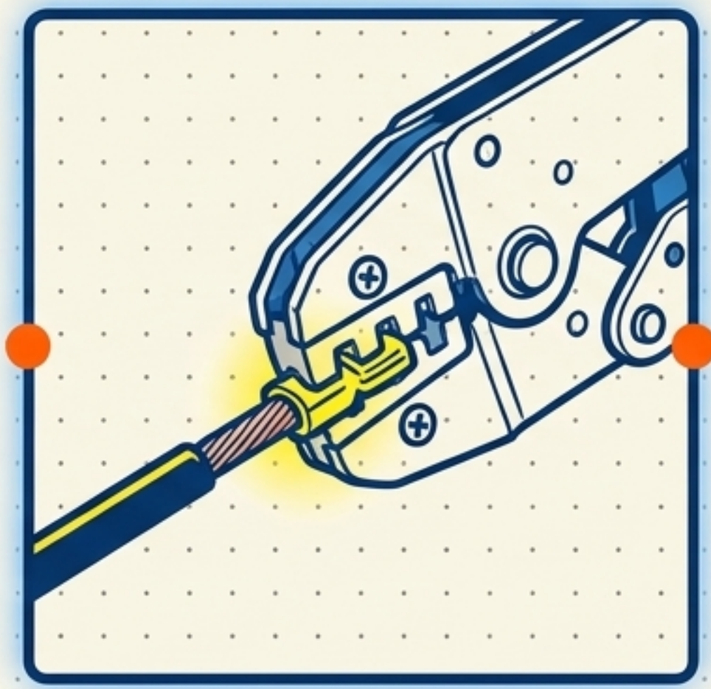
Insulation Integrity

Wires must be routed to avoid sharp edges and protected from the elements.

NotebookLM

Q10: Did you hear the ‘click’? (MC4 Connectors)

1. Strip & Prep: Pass the screw nut over the metal crimp. (Don’t forget the nut first!).



2. Crimp: Secure the male metal connector onto the 4mm cable using a crimping tool.

3. Click: Push the connector into the plastic housing until a loud “click” is heard, confirming the non-return clip is locked.

CRITICAL CAUTION: Keep all circuit breakers in the OFF position. DC voltages over 70V are highly dangerous. Sunlight = insta

NotebookLM

Q11: How do we translate the power? (Inverters)

Jagged DC Input

Smooth AC Sine Wave Output

The Translator

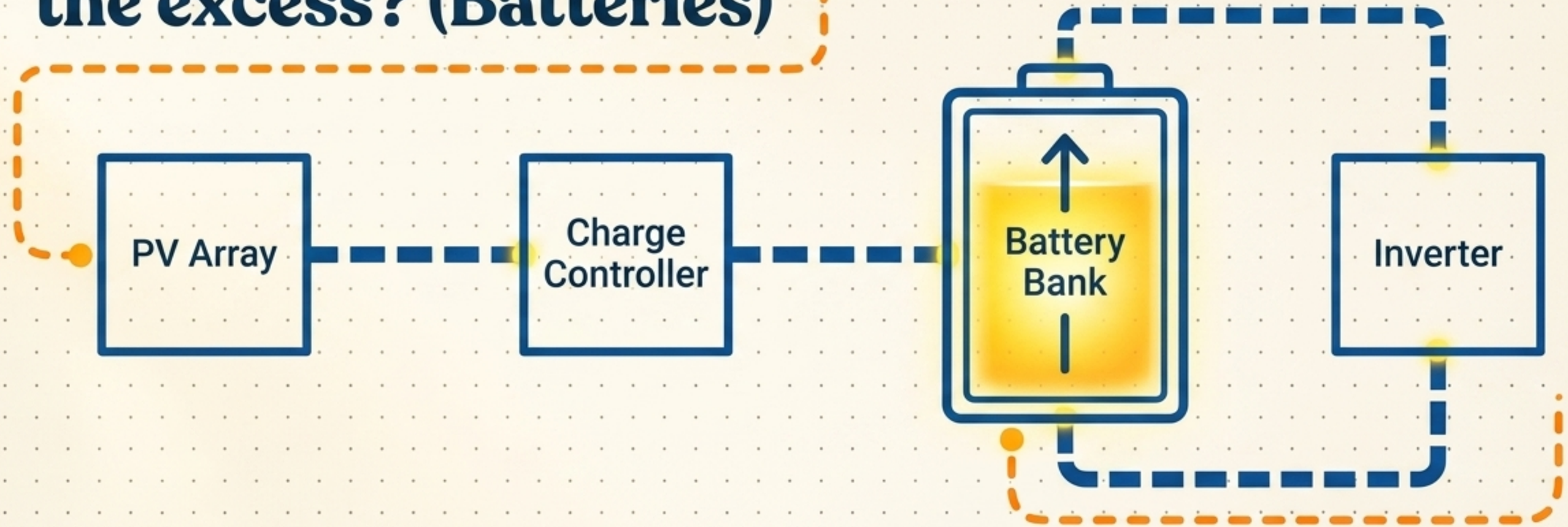
The inverter's primary job is converting DC array power into usable AC power for the main service panel.

Scale

- **String Inverters**: 1 to 12 kW range for residential/small commercial.
- **Microinverters**: Small units installed directly on or adjacent to individual PV modules.

NotebookLM

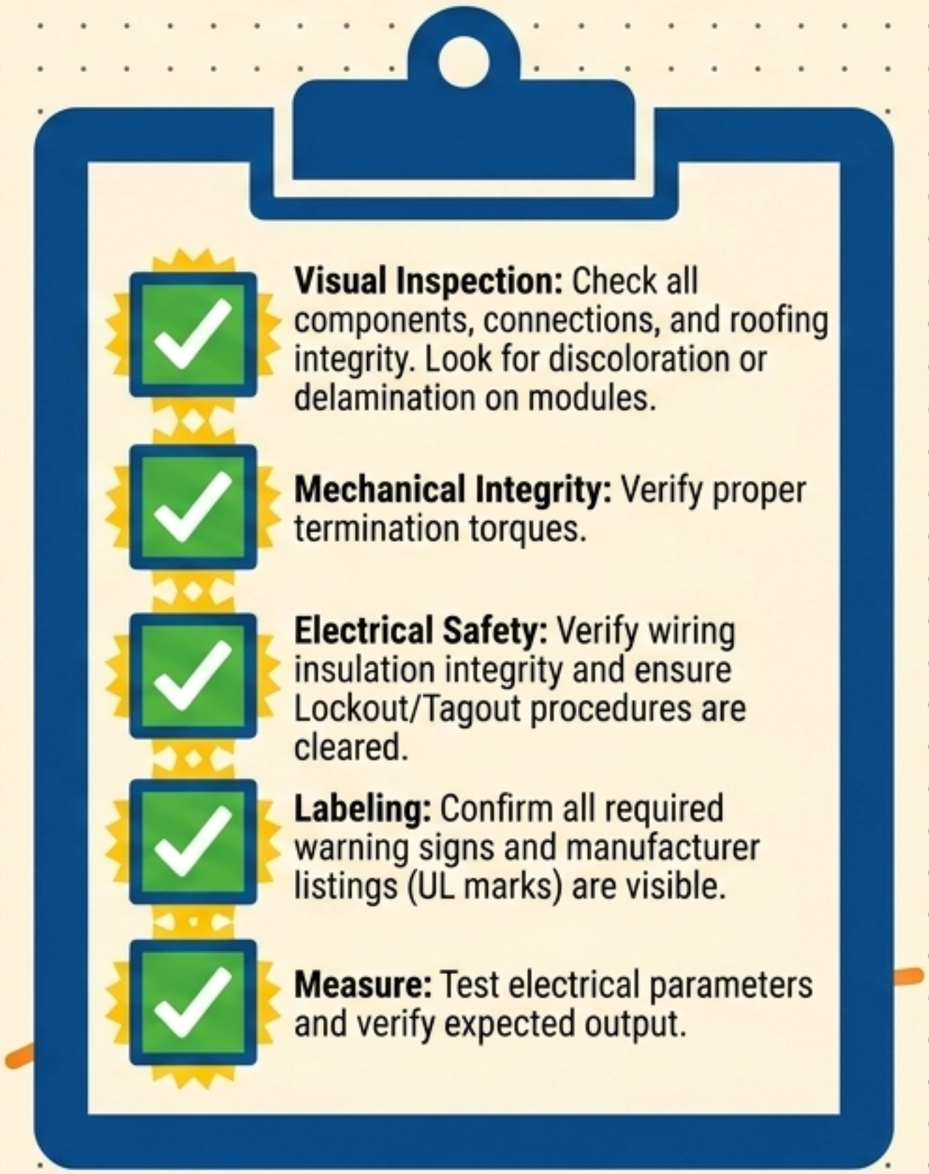
Q12: Where do we store the excess? (Batteries)



Energy Storage	System Integration	Maintenance
Batteries store energy chemically for use when the sun is down.	In a **Stand-Alone** system, the PV array charges the battery, and the battery provides DC power to the inverter.	Requires regular visual inspection for burned busbars, corrosion, and proper terminal torque.

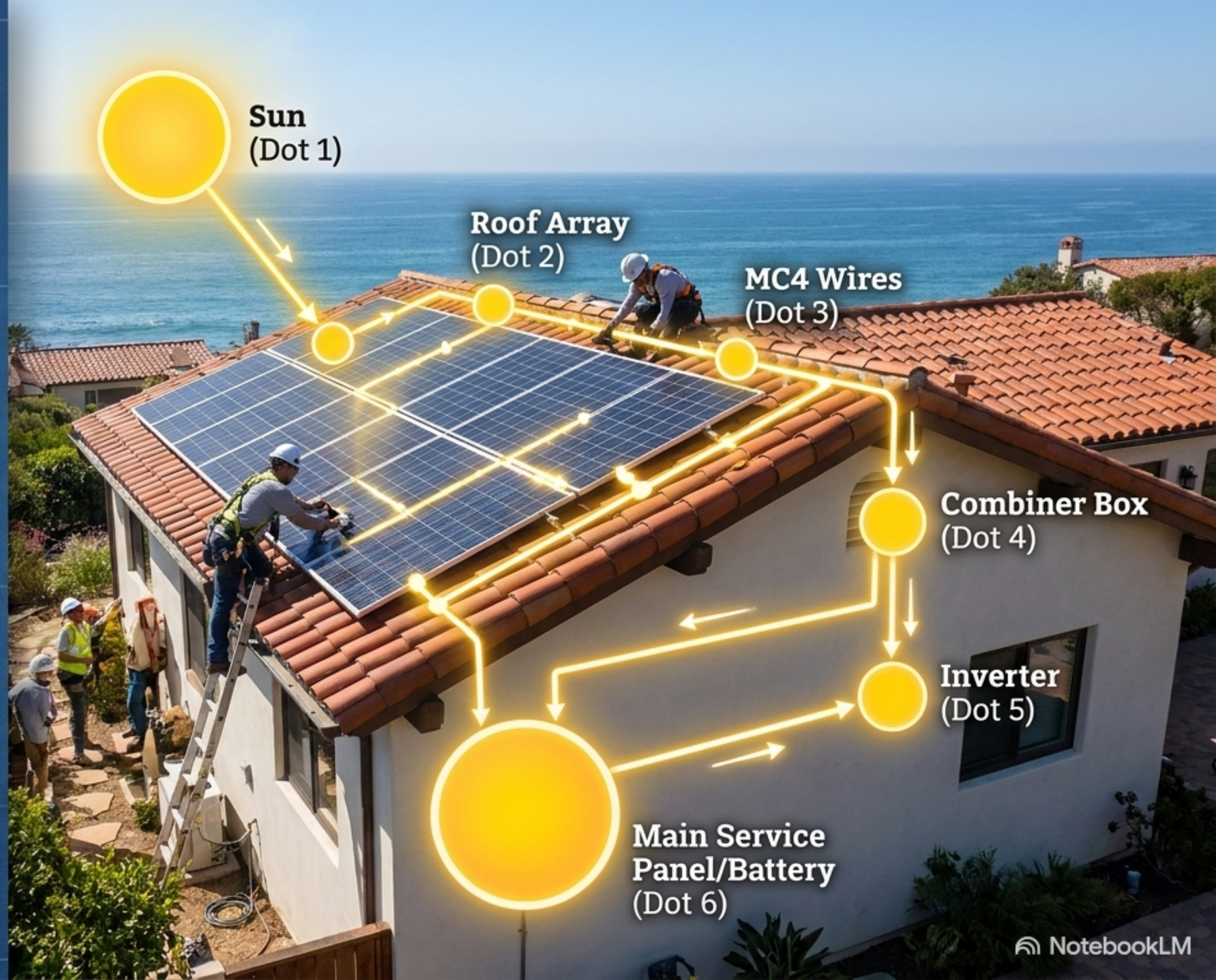
NotebookLM

Q13: Are we ready to flip the switch? (Commissioning)


Visual Inspection: Check all components, connections, and roofing integrity. Look for discoloration or delamination on modules.
Mechanical Integrity: Verify proper termination torques.
Electrical Safety: Verify wiring insulation integrity and ensure Lockout/Tagout procedures are cleared.
Labeling: Confirm all required warning signs and manufacturer listings (UL marks) are visible.
Measure: Test electrical parameters and verify expected output.

NotebookLM

Q14: What does the completed picture look like? (System Synthesis)

The Complete Blueprint

From the fusion of the sun to the AC panel in the home, you have successfully connected the solar dots. The system is commissioned, safe, and ready to generate power.